63-4-2 -

CORPORATE

WEAPON SYSTEM 107A-2

PRODUCT ENGINEERING PROGRAM

Contract AF 04(694)-212/SA3

Report 212/SA3-2.2-M-1 16 July 1963

AEROJET GENERAL TIRE GENERAL

AEROJET-GENERAL CORPORATION

SACRAMENTO, CALIFORNIA

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WEAPON SYSTEM 107A-2 13

PRODUCT ENGINEERING PROGRAM

Contract AF 04(694)-212/SA 3

1 June through 31 June 1963

Prepared by

AEROJET-GENERAL CORPORATION
Liquid Rocket Plant
Sacramento 9, California

Prepared for

BALLISTIC SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
Norton Air Force Base, California

6942

FOREWORD

This report is the first in a series of monthly reports prepared in accordance with AFBM Exhibit 58-1 and submitted in partial fulfillment of Contract AF 04(694)-212, Supplemental Agreement No. 3.

Direction for contract performance is provided by C. L. D'Ooge, Program Manager, Research and Advanced Technology Division, Liquid Rocket Plant.

The contract for the continuation of the Product Engineering Program received by Aerojet-General in mid-June, is made up of four projects:

	PROJECT TITLE	PROJECT ENGINEER
1.	Coated Metallic Thrust Chambers	S.E. Adair, Jr.
2.	Expandable Nozzle	D.M. Green
3.	Combustion Instability Scaling Concepts	F.H. Reardon
4.	Ablative Thrust Chamber Feasibility	H.H. Mueggenburg and T.A. Huges

Three of the projects are a continuation of the work conducted previously under Contract AF 04(647)-652/SA 33, and Project C is new work. The three other projects that were conducted under the project engineering contract are currently being funded under separate contracts. These are:

Metalized Thixotropic Propellants
VāPak Pressurization
Combustion Instability Periscope Development

The primary effort expended in June has been on detailed program planning and budget preparation. Several discussions with personnel of the Liquid Propulsion Laboratory, Edwards, California, have been held in the process of developing these plans.

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I. COATED METALLIC THRUST CHAMBERS

A. INTRODUCTION

1. Purpose

The objective of this project is to develop a reliable thermal barrier capable of surface temperature operation above 3300°F for use on regeneratively-cooled thrust chambers employing Aerozine 50/N_2O_4 propellant. Thermal barrier film-coating is a technique for improving liquid rocket engine performance by reducing film-cooling flow rates.

2. Approaches

The development of the thermal barriers will be accomplished in the following ways:

a. Full-scale testing of coated YLR91-AJ-5 engines (Titan II second stage) utilizing fuel film-cooling flow rates of 5% or less.

b. Laboratory thermal shock, thermal conductivity, erosion-corrosion, and metallographic testing.

B. PROGRESS DURING REPORT PERIOD

The YLR91-AJ-5 thrust chamber which was fabricated and coated on the previous product engineering contract* has been shipped to Test Area C to undergo three tests at the planned 17% fuel film-cooling flow rate for duration of 5, 10, and 15 sec. A design study is underway to determine the best means for modifying an unbaffled injector to give 5% fuel film cooling for all subsequent tests.

*AF 04(647)-652, SA33

I, B, Progress During Report Period (cont.)

Table I-1 is the program milepost chart, and Table I-2 graphically presents the test schedule.

C. NEXT REPORT PERIOD

The thrust chamber coated on the previous contract will be test fired at the normal film cooling flow rate of 17%. A 5% cooling injector design will be made and hardware modifications started. The laboratory equipment will be prepared and modified as necessary for specimen testing and full-scale coating. A special fixture for photographic coverage of the coating between full-scale tests will be made.

TABLE I-1

TEST SCHEDULE FOR COATED METALLIC THRUST CHAMBERS

Thrust Chamber	Action	Scheduled Date of Completion
1	Fabrication	Completed
	Coating	Completed
	Buildup of Thrust Chamber Assembly	7 Jul 1963
	Testing	4 Aug 1963
2	Fabrication	1 Aug 1963
	Coating	15 Aug 1963
	Buildup of Thrust Chamber Assembly	12 Sep 1963
	Testing	30 Sep 1963
3	Fabrication	9 Oct 1963
	Coating	23 Oct 1963
	Buildup of Thrust Chamber Assembly	21 Nov 1963
	Testing	8 Dec 1963
4	Fabrication	23 Dec 1963
	Coating	9 Jan 1964
	Buildup of Thrust Chamber Assembly	13 Feb 1964
	Testing	29 Feb 1964
5	Fabrication	17 Mar 1964
	Coating	2 Apr 1964
	Buildup of Thrust Chamber Assembly	30 Apr 1964
	Testing	30 May 1964

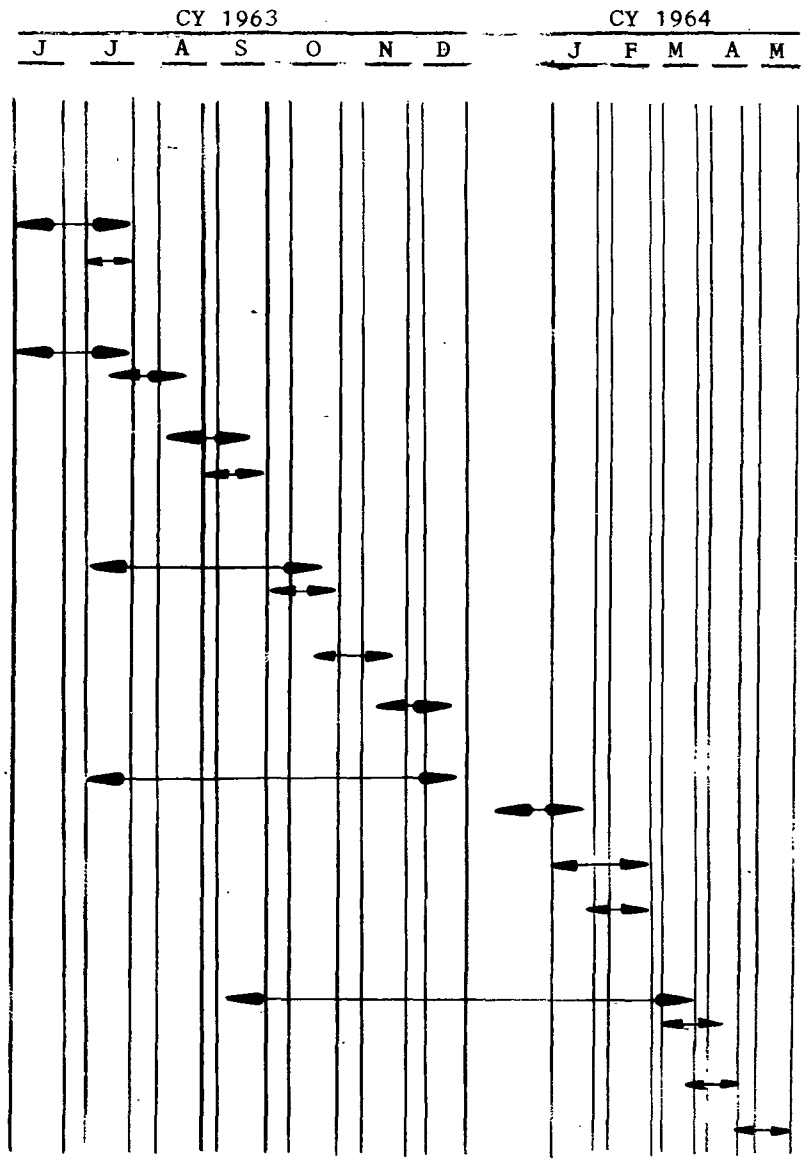

TABLE I-2

TEST SCHEDULE FOR COATED METALLIC THRUST CHAMBER TESTS

LINE NO	CURRENT CHANGE	Coated Metallic Thrust Chamber	PRESENT SCHEDULE DAY	MO	YR	PRIOR	CY 63 J	J	A	S	O	N	D	CY 64 J	F	M	A	M		LINE NO
1		Phase I - Analysis and Data Evaluation																		1
2		A. Heat Transfer																		2
3		1. Initiate	1	6	63															3
4		2. Complete	31	5	64															4
5		B. Thermal Stress																		5
6		1. Initiate	1	6	63															6
7		2. Complete	31	5	64															7
8		C. Erosion and Corrosion																		8
9		1. Initiate	1	6	63															9
10		2. Complete	31	5	64															10
11		D. Data Evaluation																		11
12		1. Initiate	1	6	63															12
13		2. Select coating for chamber 2	1	8	63															13
14		3. Select coating for chamber 3	9	10	63															14
15		4. Select coating for chamber 4	23	12	63															15
16		5. Select coating for chamber 5	17	3	64															16
1		6. Complete	30	5	64															1
2		E. Specification for Best Thermal Barrier																		2
3		1. Initiate	17	3	64															3
4		2. Complete	30	5	64															4
1		Phase II - Laboratory Investigations																		1
2		A. Initiate Laboratory Investigation	1	6	63															2
3		1. Thermal Shock Tests	1	6	63															3
4		2. Thermal Conductivity Tests	1	6	63															4
5		3. Erosion-Corrosion Tests	1	6	63															5
6		4. Coating Application Technique Dev.	1	6	63															6
7		5. Metallography	1	6	63															7
8		B. Complete Laboratory Investigation	31	5	64															8
9																				9
10																				10
11																				11
12																				12
13																				13
14																				14
15																				15
16																				16

TABLE I-2 (cont)

LINE NO	CURRENT CHANGE		PRESENT SCHEDULE DAY	MO	YR	PRIOR	CY 63 J	J	A	S	O	N	D	CY 64 J	F	M	A	M		LINE NO
1		**Phase III - Quality Control**																		1
2		**A. Initiate Contract for Studies**	1	6	63		◆													2
3		**1. Raw Material Control**	1	6	63		◆													3
4		**2. Process Control**	1	6	63		◆													4
5		**3. Destructive Sampling**	1	6	63		◆													5
6		**4. Non-destructive testing**	1	6	63		◆													6
7		**B. Complete Contract for Studies**	27	10	63						◆									7
8		**C. Laboratory Proof Tests**																		8
9		**1. Initiate**	15	8	63				◆											9
10		**2. Complete**	1	12	63								◆							10
1		Phase IV - Full Scale Testing																		1
2		A. Thrust Chamber 1																		2
3		1. Ready for TCA buildup	1	6	63		◆													3
4		2. Ready for test	7	7	63			◆												4
5		3. Testing complete	4	8	63				◆											5
6		B. Thrust Chamber 2																		6
7		1. Release for fab	1	6	63		◆													7
8		2. Ready for coating	1	8	63				◆											8
9		3. Ready for TCA buildup	15	8	63				◆											9
10		4. Ready for testing	12	9	63					◆										10
11		5. Testing complete	30	9	63					◆										11
12		C. Thrust Chamber 3																		12
13		1. Release for fab	1	6	63		◆													13
14		2. Ready for coating	9	10	63						◆									14
15		3. Ready for TCA buildup	23	10	63						◆									15
16		4. Ready for testing	21	11	63							◆								16
1		5. Testing complete	8	12	63								◆							1
2		D. Thrust Chamber 4																		2
3		1. Release for fab	1	6	63		◆													3
4		2. Ready for coating	23	12	63								◆							4
5		3. Ready for TCA buildup	9	1	64									◆						5
6		4. Ready for testing	13	2	64										◆					6
7		5. Testing complete	29	2	64										◆					7
8		E. Thrust Chamber 5																		8
9		1. Release for fab	1	9	63					◆										9
10		2. Ready for coating	17	3	64											◆				10
11		3. Ready for TCA buildup	2	4	64												◆			11
12		4. Ready for testing	30	4	64												◆			12
13		5. Testing complete	30	5	64													◆		13
14		F. Injector 1																		14
15		1. Release for fab	1	6	63		◆													15
16		2. Ready for TCA buildup	30	10	63						◆									16
1		G. Injector 2																		1
2		1. Release for modification	1	6	63		◆													2
3		2. Ready for TCA buildup	13	6	63		◆													3

II. EXPANDABLE NOZZLES

1. Purpose

The purpose of this project is to develop and test efficient packaging of high expansion ratio nozzle exit cones for rocket propulsion systems.

2. Approach

The program objectives will be accomplished by a three-phase (theoretical, fabrication, and experimental) effort. Work will be concentrated on the simulation of the nozzle conditions of the Titan II second-stage engine with both metallic and non-metallic nozzle expansion cone skirt extensions. Thrust vectoring will be investigated on an existing engine mounted on a two-axis thrust stand. A series of flight simulation tests in a wind tunnel will be conducted with scale models using various forebody shapes.

A. PROGRESS DURING REPORT PERIOD

The design has been initiated for the engine, nozzles, and deployment systems to be tested at the Arnold Engineering Development Center (AEDC). Because of the availability of the new J-4 tunnel at AEDC, the tentative approach is to use an LR-91-5 thrust chamber assembly that will operate at full Titan II conditions with nozzles up to an area ratio of 200:1.

Preliminary planning meetings for the simulated flight test program have been held with personnel from the Aeronautical Division of the Downey Plant. The locations being considered for these tests are the Jet Propulsion Laboratory, Cornell Aero Labs, and Arnold Engineering Development Center.

II, A, Progress During Report Period (cont.)

The test stand design and modifications for the thrust vector control program have been initiated for the Aerojet-General Proving Grounds at Azusa.

B. NEXT REPORT PERIOD

The activities that have been initiated will continue and a model nozzle of 12,000-lb thrust to demonstrate deployment of gas pressure, and structural stabilization will be completed.

Plans will be finalized for wind tunnel tests for external flow investigation and the AEDC J-4 tunnel for simulated altitude firings of large nozzles at high chamber pressure. Lark-engine material tests will be conducted.

TABLE II-1

EXPANDABLE NOZZLE MILEPOST CHART

LINE NO.	CURRENT CHANGE		PRESENT SCHEDULE DAY	MO	YR	LINE NO.
1		PHASE I, ENGINEERING DESIGN				1
2		A. Refinement and Correlation				2
3		of Design Programs				3
4		1. Initiated	1	6	63	4
5		2. Completed	31	5	64	5
6		B. Lark Test Hardware				6
7		1. Initiated	1	6	63	7
8		2. Completed	31	8	63	8
9		C. 12K Test Hardware				9
10		1. Initiated	1	6	63	10
11		2. Completed	31	9	63	11
12		D. Titan Size Hardware				12
13		1. Initiated	1	7	63	13
14		2. Completed	30	11	63	14
1		E. Wind Tunnel Flight				1
2		Simulation Test Hardware				2
3		1. Initiated	1	8	63	3
4		2. Completed	28	2	64	4
5		PHASE II, FABRICATION				5
6		A. Lark Hardware				6
7		1. Initiated	1	7	63	7
8		2. Completed	31	12	63	8
9		B. 12K Hardware				9
10		1. Initiated	1	7	63	10
11		2. Completed	31	12	63	11
12		C. Titan Size Hardware				12
13		1. Initiated	1	9	63	13
14		2. Completed	28	2	64	14
15						15
16						16
1		D. Wind Tunnel Support and Misc. Hardware				1
2		1. Initiated	1	9	63	2
3		2. Completed	28	2	64	3
4		E. Wind Tunnel Vehicle Models				4
5		1. Initiated	1	11	63	5
6		2. Completed	1	4	64	6
7		PHASE III, TESTING				7
8		A. Lark Material Test (Azusa)				8
9		1. Initiated	1	9	63	9
10		2. Completed	28	2	64	10
11		B. 12K TVC Test (Azusa)				11
12		1. Initiated	1	9	63	12
13		2. Completed	28	2	64	13
14		C. Titan Size Nozzles (4 AEDC)				14
15		1. Initiated	1	1	64	15
16		2. Completed	31	3	64	16
1						1
2		D. Wind Tunnel Flight Simulation				2
3		Checkout Tests (Azusa)				3
4		1. Initiated	1	12	63	4
5		2. Completed	28	2	64	5
6		E. Wind Tunnel Flight Simulation				6
7		Model Tests (Facility to be Determined)				7
8		1. Initiated	1	1	64	8
9		2. Completed	31	5	64	9

III. COMBUSTION INSTABILITY SCALING CONCEPTS

A. INTRODUCTION

1. Purpose

The Combustion Instability Scaling Concept Program is an effort to predict analytically the longitudinal modes of instability of a subscale rocket engine; to determine from testing of this engine the longitudinal mode stability limits; to compare these results; and finally to utilize the results for determining the occurrence of transverse modes of instability for larger rocket engines.

2. Approaches

This program is concerned with the stability of rocket engines as it is affected by chamber length, chamber pressure, and propellant mixture ratio. An empirical analysis will be attempted to determine the axial combustion distribution of this engine, which is required by the theoretical analysis.

For each test, a chamber pressure and a mixture ratio will be specified and held constant throughout the test. Once the thrust chamber has reached steady-state operating conditions, the chamber length will be increased during the test to study the stability effects resulting from the variation in chamber length. Two firings will be required for each operating point to keep the duration approximately 5.0 sec for each test. For the next test, the chamber pressure and/or the mixture ratio will be changed, the motor will be returned to its initial chamber length (a length to diameter ratio approximately equal to unity), and the test series continued.

The principle of the variable chamber length will be used for the combustion distribution tests along with the introduction of a water-cooled aerofoil

III, A, Introduction (cont.)

into the chamber at the exit plane to determine the energy distribution. This foil will measure nine temperatures and eight stagnation pressures at the leading edge and eight static pressures on the bottom of the foil.

B. PROGRESS DURING REPORT PERIOD

1. Thrust Chamber Assembly Design

Preliminary design and analysis was begun on the concept. The 6.0-in. diameter, cylindrical thrust chamber assembly to be used for this test series will operate within a nominal thrust range of 5000 to 10,000 lb at sea level. The chamber will be water-cooled and will operate for durations of 4.0 to 5.0 sec for each test. The hypergolic propellant combination for this test series will be nitrogen tetroxide and Aerozine 50.

The injector pattern will be the central portion of the 2SIN-0 pattern which was used on the YLR91-AJ-5 second-stage engine of Titan II. This unbaffled injector has a like-on-like impingement spray pattern.

Instead of the conventional one-element rocket exhaust nozzle, a zero-length nozzle will be utilized. This is a flat plate across the exit of the chamber with equally sized, equally spaced orifices with the sum area equivalent to the area of a conventional one-element nozzle. The purpose of this zero-length nozzle is twofold. First, the flat place across the exit improves the acoustic reflections because of the better definition of the reflection plane when compared to that of a standard exhaust nozzle. Second, the many orifices ensure that the cross section of the exhaust gas flow pattern at any one plane is relatively uniform with respect to the gas dynamics and gas properties.

III, B, Progress During Report Period (cont.)

The combustion chamber will be rigidly mounted to a support frame with recirculating ball bearing race assemblies on two of the supports, and hydraulic actuation cylinders connected to the others. Axial movements will be indicated by linear potentiometers. The hydraulic cylinders will move the combustion chamber during the test from the minimum chamber length to the maximum chamber length position. The injector will be restrained from the front of the chamber. Sealing between the injector and the chamber wall will be accomplished by either a Harrison K-seal or a Wiggins Bar-X-seal.

The chamber length will always be increased during testing to assure that the injector to chamber seals will be in progressive contact with a clean, cool surface rather than a surface that has been pitted, heated or charred by exposure to the exhaust gases.

2. Instrumentation

Two flush-mounted, water-cooled transducers will be incorporated in these tests to measure the high-frequency pressure oscillations in the chamber. One will be mounted in the exit plane of the chamber and the other will measure pressure oscillations at the injector face; therefore, the locations of these transducers will afford measurements at the boundaries of the combustion chamber. These transducers are capable of measuring frequencies up to 10,000 cps with good fidelity.

C. NEXT REPORT PERIOD

Preliminary design of the thrust chamber assembly will be continued and detail design will be initiated. Analysis efforts will begin on the theoretical calculations of instability zones.

III, B, Progress During Report Period (cont.)

The combustion chamber will be rigidly mounted to a support frame with recirculating ball bearing race assemblies on two of the supports, and hydraulic actuation cylinders connected to the others. Axial movements will be indicated by linear potentiometers. The hydraulic cylinders will move the combustion chamber during the test from the minimum chamber length to the maximum chamber length position. The injector will be restrained from the front of the chamber. Sealing between the injector and the chamber wall will be accomplished by either a Harrison K-seal or a Wiggins Bar-X-seal.

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C. NEXT REPORT PERIOD

Preliminary design of the thrust chamber assembly will be continued and detail design will be initiated. Analysis efforts will begin on the theoretical calculations of instability zones.

TABLE III-1

COMBUSTION INSTABILITY SCALING CONCEPTS MILEPOST CHART

LINE NO.	CURRENT CHANGE		PRESENT SCHEDULE DAY	MO	YR	PRIOR	Calendar Year 1963 J	J	A	S	O	N	D	Calendar Year 1964 J	F	M	A	M		LINE NO.
1		Phase I--Engineering Design																		1
2		A. Concept Completed				A														2
3		B. Predesign Initiated	1	7	63															3
4		Completed	31	8	63															4
5		C. Final Design Initiated	1	9	63															5
6		1. Mount Completed	13	9	63															6
7		2. Thrust Chamber Completed	16	9	63															7
8		3. Injector Completed	4	10	63															8
9		4. Actuation System Completed	11	10	63															9
10		Phase II--Fabrication Initiated	26	8	63															10
11		1. Mount Completed	4	11	63															11
12		2. Thrust Chamber Completed	6	12	63															12
13		3. Injector Completed	6	12	63															13
14		4. Actuation System Completed	16	12	63															14
15		5. Calibration Completed	24	12	63															15
1		Phase III--Testing Initiated	16	12	63															1
2		1. Test Stand Build-Up Completed	6	1	64															2
3		2. Calibration Firings Completed	13	1	64															3
4		3. Test Program Completed	3	31	64															4
5		Phase IV--Analysis Initiated	1	7	63															5
6		1. Calculation of Theoretical																		6
7		Instability Zones Completed	15	12	63															7
8		2. Completion of Comparison Between																		8
9		Theoretical Zones and Test Results	22	4	64															9

IV. ABLATIVE THRUST CHAMBERS

A. INTRODUCTION

1. Purpose

The purpose of this project is to demonstrate the feasibility of large ablatively cooled thrust chambers for high performance, liquid rocket engines operating at chamber pressures up to 300 psia at an appropriate mixture ratio for extended durations.

2. Approaches

Six thrust chambers fabricated under a previous contract (AF 04(647)-652/SA33) will be used with injectors developed on the Apollo service module engine program. A water-cooled transition section is required. The thrust chambers utilize the building block concept wherein molded, reinforced plastic rings are bonded together within a thin-walled steel shell (Figure IV-1). They are described in Report 652/SA 4-2.2-F-1, Volume 1, dated 28 June 1963.

B. PROGRESS DURING REPORT PERIOD

The pacing item of the ablative chamber feasibility program is the water-cooled transition section which will allow the ablative chamber to be fired with an Apollo injector. The heat transfer analysis and design of this transition section has been initiated and should be completed in July.

The test history of the existing Apollo injectors is currently being investigated to determine a possible candidate injector that will satisfy the necessary technical requirements of the ablative chamber feasibility program.

IV, B, Progress During Report Period (cont.)

Two additional steel shells for the ablative chambers are being fabricated. The additional shells will serve two purposes: (1) if one of the shells designated for reuse were damaged on the first firing, the firing of the last two chambers would be delayed, and (2) the final assembly of the last two chambers can proceed without delays caused by waiting for shells to become available. The design of these two steel shells has been revised to allow for the diametrical age that was experienced on the original four shells during welding. The end flanges of the shells were strengthened and simplified to reduce out-of-phase distortion, and the method of welding has been changed to achieve this end. The ablative chambers are being completed as necessary. The chambers that have been fabricated are:

Part No.	Chamber Material	Throat Material
284528-9	Silica roving-modified phenolic resin.	Same as chamber. Cylindrical throat configuration.
278120-149	Silica roving-modified phenolic resin.	Pyrolytic deposit of tantalum carbide on graphite. Asbestos phenolic insulation.
278120-259	Asbestos-phenolic.	ATJ graphite. Asbestos phenolic insulation.
278120-189	Asbestos-phenolic.	Pyrolytic deposit of tantalum carbide on graphite. Asbestos phenolic insulation.
284528-29	Silica roving-elastomer modified phenyl silane resin.	Same as chamber. Cylindrical throat configuration.
278120-219	Silica roving-modified phenolic resin.	ZTA graphite. Asbestos phenolic insulation.

IV, B, Progress During Report Period (cont.)

Specific Identification of Materials

Material	Manufacturer
Silica roving-modified phenolic resin, FM 5073	U.S. Polymeric
Asbestos phenolic, Thermomatt 193	Johns-Manville
Silica roving-elastomer modified phenyl-silane resin, X-2017	U.S. Polymeric
Pyrolytic tantalum carbide coating on graphite	High Temperature Materials, Inc.
ATJ graphite and ZTA graphite	National Carbon Company

The first chamber (P/N 284528-9) is ready for immediate firing. The second, third, and fourth assemblies listed are installed in their metal shells and require only interior contouring before firing. Because the 91-3 injector will not be used in the ablative chambers program as originally planned, the recessed lip on the forward end of the ablative chambers will no longer be required and will be removed from the applicable drawings.

Injector checkout tests are currently scheduled during October and November with ablative chamber testing immediately following during December and January. Table IV-1 shows the milepost schedule for the ablative chamber project.

C. NEXT REPORT PERIOD

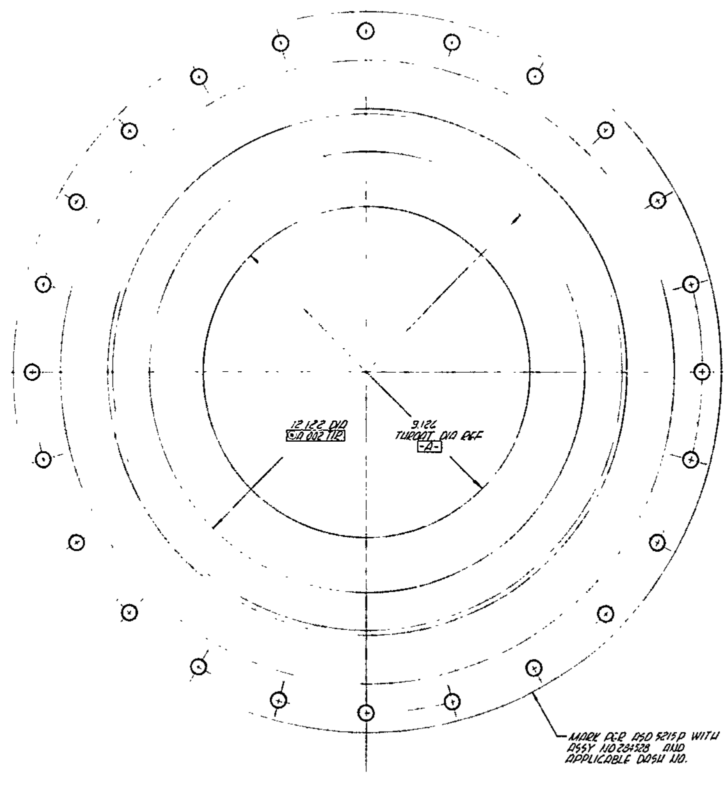
Upon completion of the transition section design, fabrication orders will be initiated. The most promising Apollo injector will be obtained and reworked if necessary to be available for checkout tests with the transition section.

TABLE IV-1

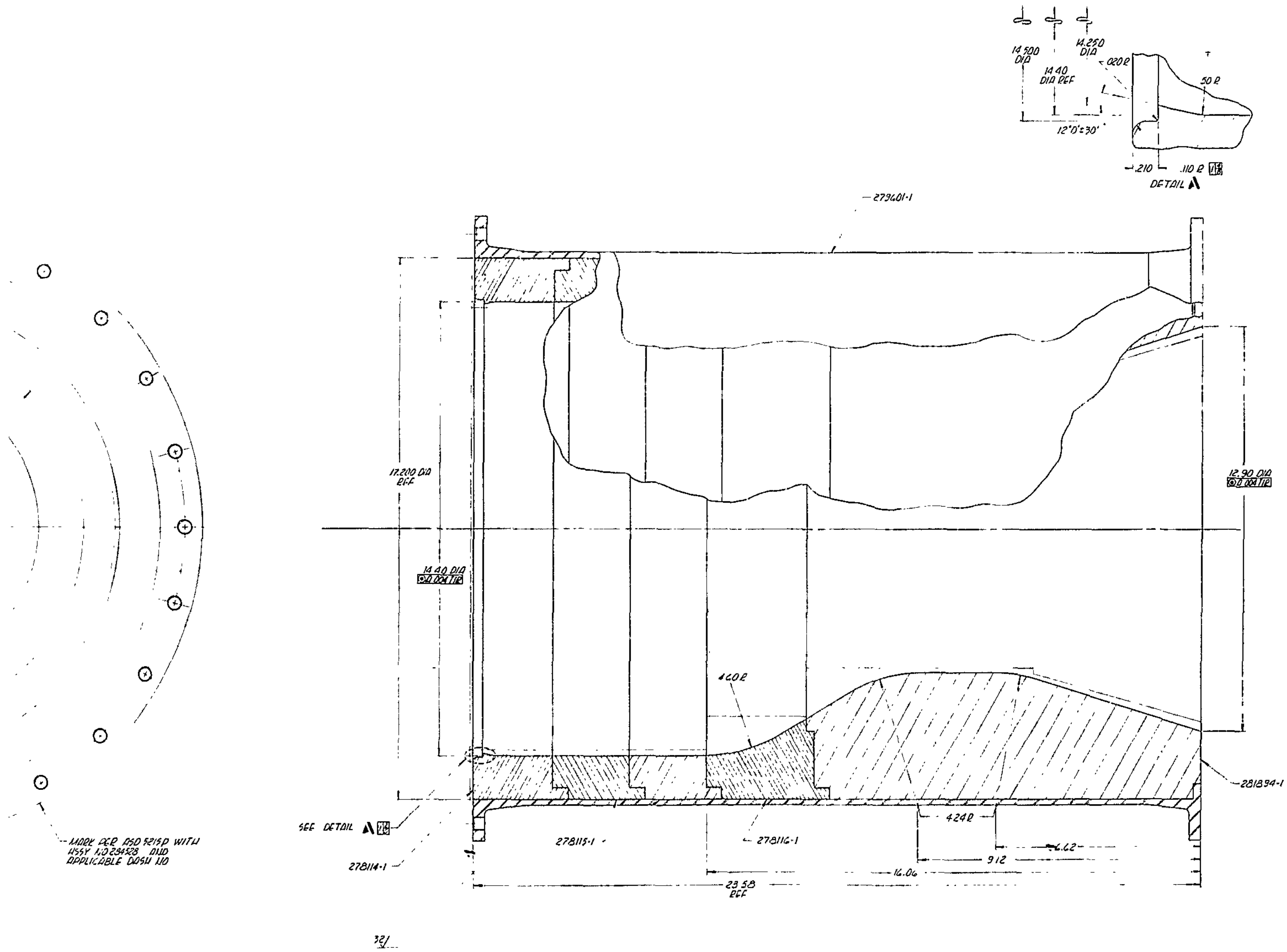
ABLATIVE THRUST CHAMBERS FEASIBILITY MILEPOST CHART

LINE NO.	CURRENT CHANGE		PRESENT SCHEDULE DAY	MO	YR	PRIOR	1963 J	J	A	S	O	N	D	1964 J	F	M	A	M		LINE NO.
1		Phase I - Test Preparation																		1
2		A. Design of Ablative Chamber					A													2
3		B. Fabrication of Ablative Chamber																		3
4		1. Chamber 284528-9					A													4
5		2. Chamber 278120-14[illegible]	31	8	63															5
6		3. Chamber 278120-259	31	8	63															6
7		4. Chamber 278120-189	31	8	63															7
8		5. Chamber 284528-29	31	8	63															8
9		6. Chamber 278120-219	31	8	63															9
10		C. Design of Metal Shell					A													10
11		D. Fabrication of Metal Shell	31	8	63															11
12		E. Design of Transition Section	30	9	63															12
13		1. Heat Transfer Analysis	31	8	63															13
14		F. Fabrication of Transition Section	30	10	63															14
15		G. Selection of Injectors	31	8	63															15
16		H. Injector Fabrication	30	9	63															16
1		I. Uncooled chamber Acquisition					A													1
2		J. Selection of Instrumentation	30	9	63															2
3		K. Selection of Firing Parameters	15	11	63															3
4		L. Ablative Chamber Assembly	31	12	63															4
5		M. Installation of Instrumentation	30	11	63															5
6		Phase II - Firing Tests																		6
7		A. Injector Check-out	30	11	63															7
8		B. Ablative Chamber Test	31	1	63															8
9																				9
10		Phase III - Data Evaluation																		10
11		A. Data Reduction	21	2	64															11
12		B. Chamber Evaluation																		12
13		1. Performance	16	3	64															13
14		2. Materials Evaluation	16	3	64															14
15		3. Comparison with Subscale Tests	15	4	64															15
16																				16

NOTES
1 REMOVE ALL BURRS AND SHARP EDGES
2. SYMBOLS PER MIL-STD-8 & MIL-STD-12.
3. CLEAN PER AGC-46350, LEVEL H
4. PRESERVE & PACKAGE PER AGC-46387, CLASS I



1



Uncooled Combustion Chamber, Cylindrical Throat Configuration

Figure IV-1

V. PROGRAM REPORTING

Table V-1 shows the schedule of reports that will be submitted for this contract.

TABLE V-1

PROGRAM REPORTING MILEPOST CHART

LINE NO.	CURRENT CHANGE		PRESENT SCHEDULE DAY	MO	YR
1		1. Program Reporting			
2		a. Financial Status Report			
3		1st Quarter	25	8	63
4		2nd Quarter	25	11	63
5		3rd Quarter	25	2	64
6		4th Quarter	25	5	64
7		b. Funding Status Report			
8		June 1963	10	7	63
9		July 1963	10	8	63
10		August 1963	10	9	63
11		September 1963	10	10	63
12		October 1963	10	11	63
13		November 1963	10	12	63
14		December 1963	10	1	63
15		January 1964	10	2	64
16					
1		February 1964	10	3	64
2		March 1964	10	4	64
3		April 1964	10	5	64
4		May 1964	10	6	64
5		c. Manpower Status Report			
6		June 1963	10	7	63
7		July 1963	10	8	63
8		August 1963	10	9	63
9		September 1963	10	10	63
10		October 1963	10	11	63
11		November 1963	10	12	63
12		December 1963	10	1	64
13		January 1964	10	2	64
14		February 1964	10	3	64
15		March 1964	10	4	64
16		April 1964	10	5	65
1		May	10	6	64
2		d. Program Progress Report			
3		(Monthly)			
4		June 1963	20	7	63
5		July 1963	20	8	63
6		September 1963	20	10	63
7		October 1963	20	11	63
8		December 1963	20	1	64
9		January 1964	20	2	64
10		March 1964	20	4	64
11		April 1964	20	5	64
12		e. Program Progress Report			
13		(Quarterly)			
14		August 1963	20	9	63
15		November 1963	20	12	63
16		February 1963	20	3	63
1		f. Final Program Report	15	7	64
2		g. Documentary Film	15	7	64

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